AMS-491

Evaluation of a Small-Scale and a Large-Scale

COTTON SPINNING PERFORMANCE TEST

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CONTENTS

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EVALUATION OF A SMALL-SCALE AND A LARGE-SCALE COTTON SPINNING PERFORMANCE TEST

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INTRODUCTION

The spinning performance of cotton is an important consideration in the processing of cotton into consumer products. Large-scale tests, to be significant, require many spindle hours of operation and large amounts of cotton. A better and faster method of testing spinning performance would benefit the many segments of the cotton industry.

The Market Quality Research Division's Pilot Spinning Plant at Clemson College, Clemson, S. C., is measuring spinning performance by spinning several hundred pounds of cotton on 1,008 spindles and determining the number of ends down (yarn breakage) per 1,000 spindle hours of operation.

The small-scale method of measuring spinning performance needs only 10 pounds of cotton to be spun on 84 spindles to determine the spinning limit of the cotton. The spinnable limit yarn number of a test cotton is defined as the yarn number calculated to produce 20 ends down per hour on 84 spindles, when procedures outlined in this report are used. The principle of the spinning performance (spinnable limit) test was conceived jointly by the Cotton Division and the Market Quality Research Division of USDA's Agricultural Marketing Service. Details for this method are given in a preliminary report by Eddins and Burley published in February 1959. 1/ Then, at the Cotton Research Clinic in May 1959, Burley presented a paper 2/ on the analysis of data obtained from 12 ginning conditions using the small-scale spinnable limit tests. It was concluded that, with further refinement, this test method could be used to detect the effects of harvesting, ginning, and manufacturing practices on the spinning performance of cotton. Only the effects of ginning practices are included in this report.

The research on which this report is based is part of a broad program of continuing research designed to improve product quality and to increase efficiency of the marketing processes for farm products.

1/ Eddins, Frank S., and Burley, Samuel T., Jr. A Method of Evaluating Spinning Performance of Cotton. Preliminary Report. U. S. Dept. Agr. AMS-299, 11 pp., illus. February 1959.

2/ Burley, Samuel T., Jr. A Method for Determining the Effects of Various Gin Treatments on the Spinnability of Cotton. Paper presented at the Cotton Research Clinic sponsored by the National Cotton Council of America, at Asheville, N. C., 8 pp., illus. May 12-14, 1959.

OBJECTIVE

The objective of the study was to further develop a reliable and meaningful small-scale spinning performance test that is related to the large-scale spinning tests being made in the Market Quality Research Division's Pilot Spinning Laboratory.

SOURCE OF COTTONS

The material for this study came from 81 bales of rain-grown cotton that was being processed by the pilot plant. This cotton ranged in grade from Good Ordinary to Middling and in staple length from 1-1/32 to 1-1/16 inches. These bales consisted of machine-picked cotton which had been ginned under three levels of lint moisture, three levels of seed-cotton cleaning, and three levels of lint cleaning. Each ginning condition was replicated three times.

PROCEDURE

All lots in this study were passed through the opening, picking, carding, and drawing processes using the same manufacturing organization. At the roving process, 1.25-hank roving was made for the 1,008-spindles test, and 1.80-hank roving was made for the finer yarns spun for the 84-spindles test.

Roving was creeled singly in the spinning frames, and one full doff (spinning bobbins completely filled) each of 40's and 50's yarns was spun with a 3.75 twist multiplier and a spindle speed of 11,000 r.p.m. (revolutions per minute) for the large-scale tests.

Roving was creeled singly in a spinning frame with 84 spindles, using a twist multiplier of 4.00 and a spindle speed of 9,000 r.p.m. for the small-scale tests. A minimum of four yarn numbers was spun for each test cotton. Since the finest adjustment is one tooth in the twist or draft gear and one number in the traveler weight size, the desired yarn numbers were calculated using the following formula:

$$\text{Yarn number} = \left(\frac{\text{twist constant}}{\text{twist multiplier X twist gear}}\right)^2$$

The same style of traveler was used throughout the test. A progressively lighter traveler was used as each yarn number became progressively finer. The following yarn numbers were common for all lots included in this study, although finer yarn numbers were spun from some lots:

Size			
Yarn No.	Tex No.	Traveler No.	Twist Gear
54.5	10.85	15/0	34
61.2	9.65	16/0	32
65.3	9.05	17/0	31
69.7	8.45	18/0	30

The spinning frame was set up to spin the lowest yarn number listed above, and then run for 20 minutes to determine whether the correct draft gear had been selected. After the correct draft gear had been determined, new travelers were placed on the rings; the ring rail was adjusted to wind the yarn near the middle portion of the bobbin; and the frame was run for 15 minutes to break in the travelers. Then, ends down were recorded for 1 hour. At the end of the hour, the yarn was again sized, and if the size was more than plus or minus one yarn number from the desired number, a rerun was made. This sizing was also used to calculate the draft gear for the next yarn number. This procedure was used for each yarn number spun.

The spinnable limit yarn number was determined by the method of least squares from the yarn numbers spun and the ends down recorded. A linear correlation regression of ends down vs. yarn number was calculated, and the yarn-number value, at the level of 20 ends down, was determined as the "spinnable limit value" of the cotton (fig. 1).

RESULTS

For both methods, the number of yarn breaks during spinning was converted to ends down per 1,000 spindle hours, hereafter referred to as EDMSH. Four comparisons were made of the two methods: (1) EDMSH for 40's yarn with EDMSH for 50's yarn spun by the large-scale spinning tests, (2) spinnable limit yarn number, 3/ determined from the small-scale test, with EDMSH obtained from the large-scale test, (3) EDMSH for each of the four yarns spun for the small-scale test, and (4) EDMSH from small-scale test with the large-scale test. Comparisons are limited to the effects of lint moisture content (taken at the gin lint-slide) and of gin lint cleaners on the spinning performance of the cotton. Seed-cotton cleaning showed little or no effect on spinning performance.

Comparison of EDMSH for 40's and 50's Yarn, Large-Scale Spinning Test

Opposite trends in spinning performance were obtained for 40's and 50's yarn (charts 1 and 2, fig. 2). As the lint moisture content decreased, there was an apparent decrease in average EDMSH for 40's yarn; however, the difference was not significant.

As the lint moisture content decreased, EDMSH increased significantly for 50's yarn from an average of 84 for high moisture to an average of 172 for low moisture (chart 2, fig. 2).

Cottons subjected to different levels of lint cleaning did not produce the same trend for different yarn numbers. An increase in lint cleaning caused a significant decrease in EDMSH for 40's yarn. The ginning organization using

3/ A higher yarn number obtained from the small-scale test and low EDMSH obtained from the large-scale test indicated better spinning performance. These comparisons are shown in figure 2.

no lint cleaning produced 40 EDMSH, while the organization using two lint cleaners produced 32 EDMSH.

When 50's yarn was spun, the relation was reversed. As lint cleaners were added, EDMSH increased significantly, from 97 for no lint cleaning to 157 for two lint cleaners.

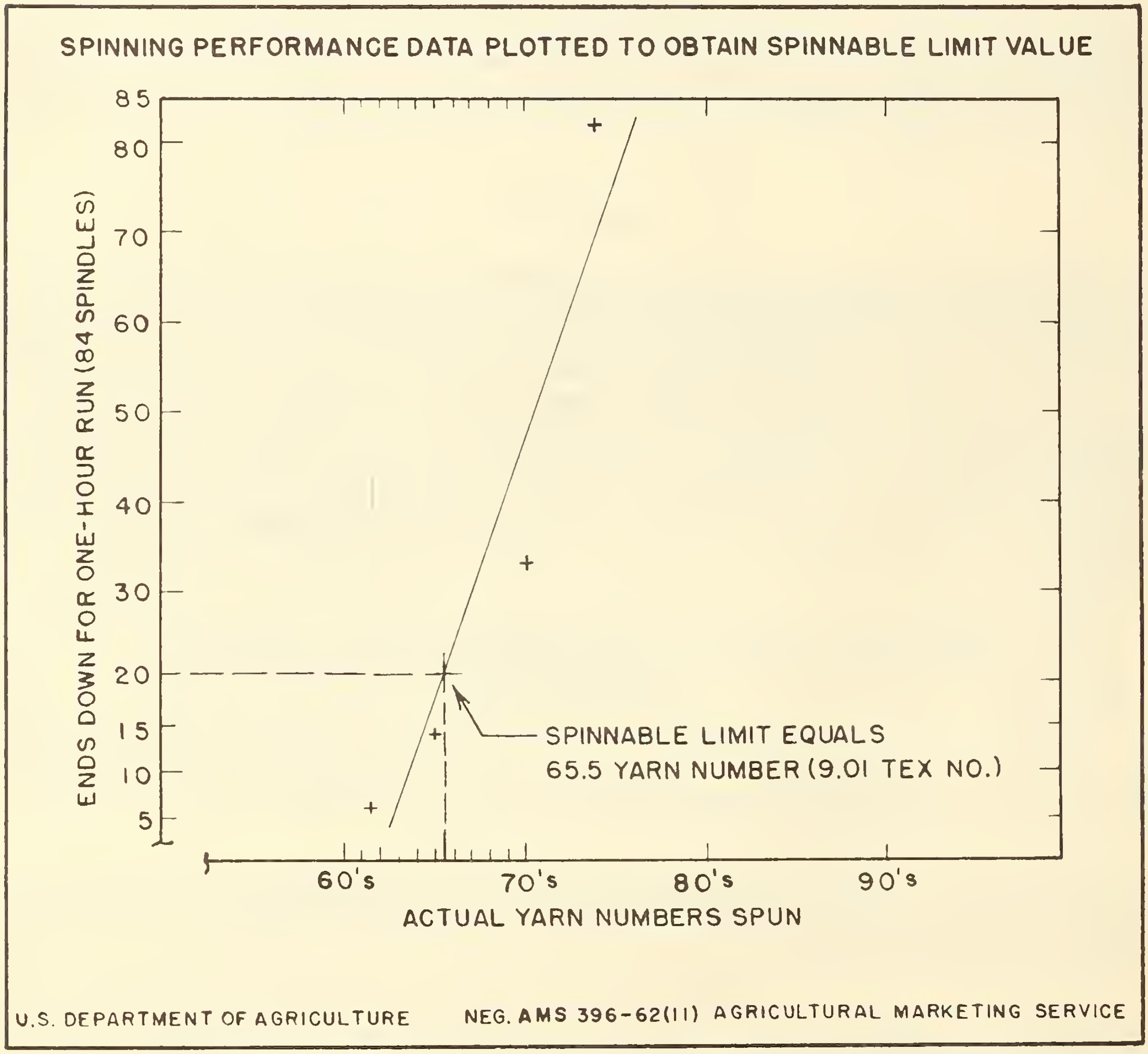

Figure 1

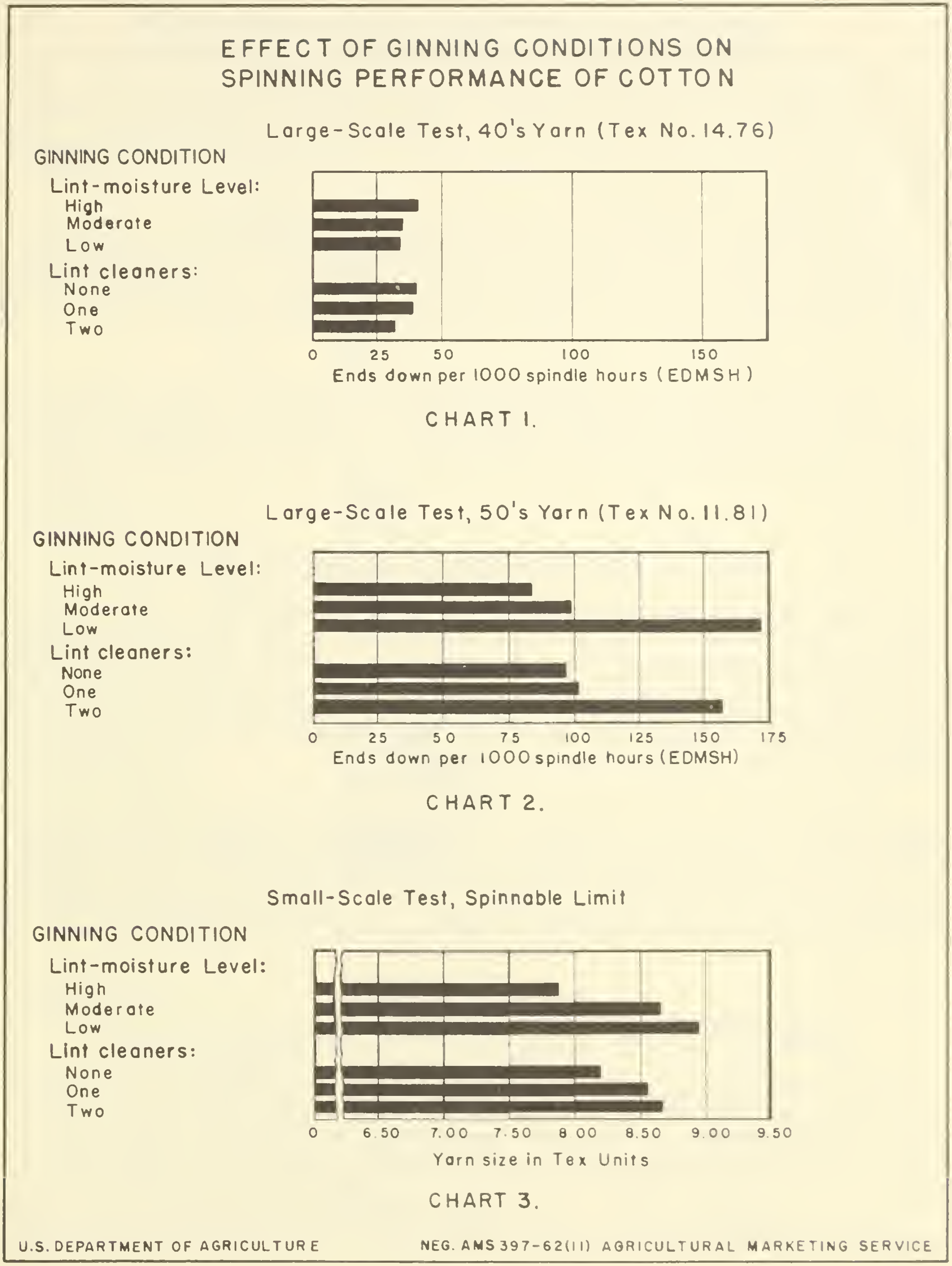
EFFECT OF GINNING CONDITIONS ON SPINNING PERFORMANCE OF COTTON
Large-Scale Test, 40's Yarn (Tex No. 14.76)
GINNING CONDITION
Lint-moisture Level:
High
Moderate
Low
Lint cleaners:
None
One
Two
0 25 50 100 150
Ends down per 1000 spindle hours (EDMSH)
CHART 1.
Large-Scale Test, 50's Yarn (Tex No. 11.81)
GINNING CONDITION
Lint-moisture Level:
High
Moderate
Low
Lint cleaners:
None
One
Two
0 25 50 75 100 125 150 175
Ends down per 1000 spindle hours (EDMSH)
CHART 2.
Small-Scale Test, Spinnable Limit
GINNING CONDITION
Lint-moisture Level:
High
Moderate
Low
Lint cleaners:
None
One
Two
0 6.50 7.00 7.50 8.00 8.50 9.00 9.50
Yarn size in Tex Units
CHART 3.
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Figure 2

Comparison of the Spinnable Limit Yarn Number for the Small-Scale Test with EDMSH of the Large-Scale Test

The spinnable limit yarn numbers of the small-scale spinning test are shown on chart 3, figure 2, as values of tex units for each ginning condition. This value is used in the chart so the trend of the effects of these ginning conditions will be in the same direction as those shown for the large-scale spinning tests.

The spinning performance, as determined from the small-scale test, increased significantly with high-level moisture compared with low-level moisture (chart 3, fig. 2). This same trend was shown by the large-scale test for EDMSH of 50's yarn (chart 2, fig. 2), but for 40's yarn (chart 1, fig. 2) the trend was reversed.

The effects of lint cleaners on spinning performance by the small-scale method followed the same trend as EDMSH for 50's yarn, but was opposite to the trend for 40's yarn. The use of lint cleaners lowered the spinning performance, as shown by the small-scale test and by 50's yarn in the large-scale test.

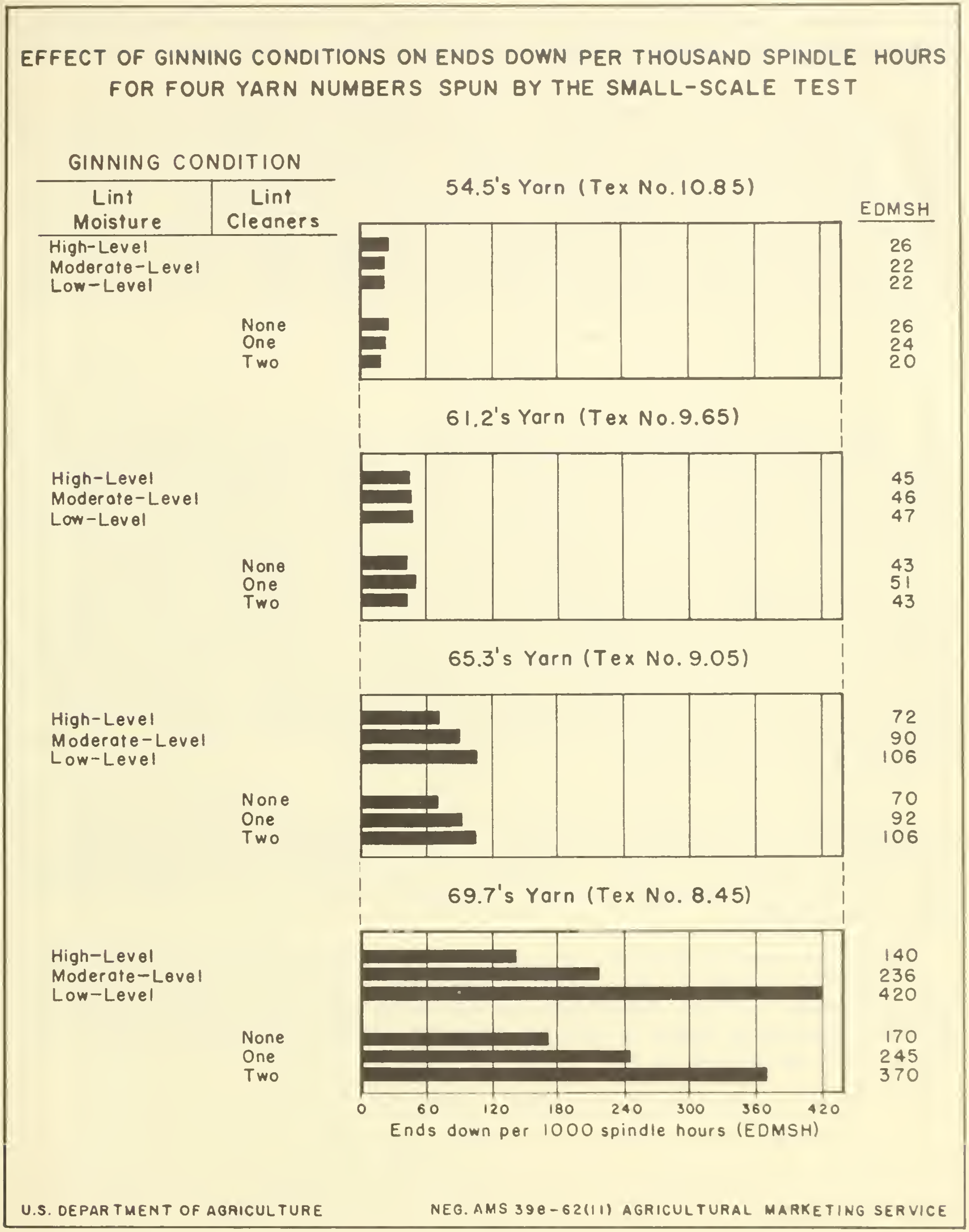
EDMSH for Four Yarns Spun in the Small-Scale Test

The effects of lint moisture content did not produce the same trend for the four yarn numbers (fig. 3). For 54.5's yarn, as the moisture decreased, EDMSH decreased slightly, but not significantly. For 61.2's yarn, a decrease in moisture caused a slight, though not significant, increase in EDMSH. For 65.3's yarn and 69.7's yarn, a definite trend in EDMSH was established; as the moisture decreased, EDMSH increased significantly from 72 to 106 for 65.3's yarn and from 140 to 420 for 69.7's yarn.

The effects of lint cleaners on EDMSH for the four yarn numbers of the small-scale test were not the same (fig. 3). For 54.5's yarn, the addition of lint cleaners caused a slight decrease in EDMSH from 26 for no lint cleaners to 20 for two lint cleaners. For 61.2's yarn, the effects of lint cleaning were not consistent. With the addition of lint cleaners, EDMSH increased significantly from 70 to 106 for 65.3's and from 170 to 370 for 69.7's yarn.

Comparison of EDMSH in Small-Scale Test and Large-Scale Test

Lint moisture content produced approximately the same trend in EDMSH in the small-scale test as in the large-scale test, for their respective levels of yarn numbers (figs. 2 and 3 for comparison). For example, lots ginned with a low level of moisture had less ends down than the lots ginned with a high level of moisture for 54.5's yarn in the small-scale test and for 40's yarn in the large-scale test. The level of ginned lint moisture did not seem to affect the EDMSH for 61.2's yarn. The trend of EDMSH for 65.3's yarn and



EFFECT OF GINNING CONDITIONS ON ENDS DOWN PER THOUSAND SPINDLE HOURS FOR FOUR YARN NUMBERS SPUN BY THE SMALL-SCALE TEST
GINNING CONDITION
Lint Moisture
Lint Cleaners
54.5's Yarn (Tex No. 10.85)
EDMSH
High-Level
Moderate-Level
Low-Level
None
One
Two
26
22
22
26
24
20
61.2's Yarn (Tex No. 9.65)
High-Level
Moderate-Level
Low-Level
None
One
Two
45
46
47
43
51
43
65.3's Yarn (Tex No. 9.05)
High-Level
Moderate-Level
Low-Level
None
One
Two
72
90
106
70
92
106
69.7's Yarn (Tex No. 8.45)
High-Level
Moderate-Level
Low-Level
None
One
Two
140
236
420
170
245
370
0
60
120
180
240
300
360
420
Ends down per 1000 spindle hours (EDMSH)
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Figure 3

69.7's yarn in the small-scale test corresponded with the trend established for 50's yarn in the large-scale test; that is, the high-moisture lots spun better than the low-moisture lots.

The effects of lint cleaners on EDMSH in the large-scale test approximately paralleled those of the small-scale test for their respective levels of yarn numbers (figs. 2 and 3 for comparison). EDMSH for 54.5's yarn in the small-scale test followed the same trend as EDMSH for 40's yarn in the large-scale test--a decrease in EDMSH with an increase in lint cleaning. The trend of EDMSH for 61.2's yarn in the small-scale test did not consistently follow trends established by either yarn number of the large-scale test. The trend of EDMSH for 65.3's yarn and 69.7's yarn in the small-scale test approximated the trend of EDMSH for 50's yarn in the large-scale test.

DISCUSSION

Some interesting observations can be noted in the results obtained from the large-scale and small-scale spinning performance tests. Within each of the two spinning performance tests, the relationship of ginning conditions to end-breakage changes, or even reverses, with yarn size spun (40's and 50's yarn spun in large-scale tests and 54.5's, 61.2's, 65.3's, and 69.7's yarn spun in the small-scale test). The results obtained from a large-scale test with only one yarn number being spun will not sufficiently evaluate a cotton's spinning performance unless the cotton is spun at a sensitive level of end breakage. The 40's yarn was spun for low-level end breakage of approximately 30 EDMSH, while the 50's yarn was spun for a more sensitive level, or a much higher end breakage, at approximately 100 EDMSH. If the 40's yarn had been spun with a lower twist multiplier or higher spindle speed, it may be that the EDMSH would have approached the sensitive zone of spinnable limits and the relationship of ginning conditions and EDMSH would have been the same as those obtained for the 50's yarn.

Apparently the spinnable limit yarn obtained from the small-scale test is indicative of the spinning performance of a cotton spun near the sensitive zone (50 to 100 EDMSH) by the large-scale method. This is indicated by a similar relationship with ginning conditions as obtained from 50's yarn spun in large-scale tests.

When the overall results are compared, both test methods described generally rank the cottons in this study in the same order as to spinning performance. However, further investigations are being made with both the small-scale and the large-scale tests to determine how to properly relate the results obtained from one method to those of the other.